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Micro-architecture of pore space revealed by neutron scattering

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Pore sizes in sedimentary rocks vary over five orders of magnitude, from sub-nanometre to hundreds of micrometers, depending on the rock type. Many fundamental phenomena (e.g. flow and sorption of fluids, capillary condensation, geo-bio interactions, hydrocarbon generation and primary migration) occur on nano-scale, either within the solid rock matrix, at the pore-matrix interface or within the confinement of nano-pores. In contrast, macroscopic flow of fluids is directed through the largest of connected pores, usually of supra-micrometer size.
The SAS (small-angle scattering) techniques using neutrons (SANS and USANS) or X-rays (SAXS and USAXS) have been used in the last two decades to probe the microstructure of rocks on the linear scale from sub-nanometres to about 10 μm. SAS methods are non-invasive, quantitative and provide statistically significant data space-averaged over a selectable macroscopic sample volume. SAS has been used regardless of the permeability (tight shales as well as porous sandstones and carbonates), composition (organic or inorganic) or the form of rock sample (oriented solid slices, drilling chips, coarse grains) [1].
SAS results are used to determine from first principles the key microstructural attributes: total porosity and internal specific surface area (SSA). Pore-matrix interface is often fractal and the magnitude of SSA is scale-dependent, which provides means to independently verify values obtained using gas adsorption or mercury intrusion porosimetry. In particular, specific models of pore geometry are used to calculate the distribution of pore sizes [1].
The most recent aspect of SAS research, contrast matching with compressed gases [2], makes it possible to mask the accessible pores and determine the porosity, pore size distribution and SSA for the inaccessible pores only. Corresponding properties of the accessible pores are obtained by subtraction, therefore both pore types can be characterised. Two aspects of this line of research appear to be most promising: (1) accessibility of nanopores and capillary condensation in natural-gas-bearing formations [3,4] and (2) modification of the microstructure of carbonates by dissolution during reactive flow.
This presentation will be illustrated with the results of SAS measurements of microstructural properties for coals, shales and carbonates, with emphasis on contrast matching data.

[1] Radlinski, A.P. (2006). Rev. Mineral. Geochem. 63, 363-397
[2] Radlinski, A.P. et al. (2009). Langmuir 25, 2385-2389
[3] He, L. et al. (2012). Energy & Fuels 26, 1975-1983
[4] Clarkson, C.R. et al. (2013). Fuel 103, 606-616